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Reduction in the daily rainfall gauge network in England and Wales

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Summary

The measurement of daily rainfall totals in England and Wales is made by about 4000 gauges at present. Many of these gauges are administered by the Water Authorities and other organizations, and their observations are sent to the Meteorological Office. These organizations and the Meteorological Office are having to reduce the resources allotted to the handling of these observations and, as a consequence, the total number of gauges is being reduced, but with some redistribution.

This paper describes the reduction procedure, which is designed to preserve the general quality and usefulness of the rainfall archive, and its implementation.

1. Historical perspective

It is not surprising that for many hundreds of years the British people have recorded an interest in the amount of rain that falls on these islands. The variation with locality, reflected in the contrast between the wet highlands of the west and north and the drier lowlands of the south and east, and the variation of duration and intensity, reflected in the contrast between heavy summer showers and the long, unremitting rain of winter storms, has raised scientific curiosity about rainfall as well as making it a subject for daily conversation.

Naturally a phenomenon of such relevance to everyday lives required rigorous and regular observation. Sir Christopher Wren is credited with the invention, about 1660, of two of the earliest known rain-gauges in Britain. There is no evidence, however, that the architect himself ever used the gauges for making regular measurements, which became more the interest of 'gentlemen-philosophers' who wished to use their wealth and leisure in scientific pursuits.

A Mr Richard Towneley (1629–1707), of Towneley Hall near Burnley, is generally acknowledged to be the first British observer to make and record regular observations of daily rainfalls as we understand them today, starting in January 1677 and continuing until his death. He believed in simplicity. His gauge consisted of a funnel to channel rain into a simple graduated measuring cylinder, much the same principle as is still used today in simple storage gauges. He believed in comfort as well. The funnel was mounted on his roof, with a long pipe leading indoors so that he could make his measurements in the dry.

2. British Rainfall Organization

During the 18th and early 19th centuries many different types of gauge were developed with funnels on roofs, towers, walls and on the ground, but there was no central co-ordination of measurements of rainfall and their recording. This was the situation until 1860 when J. G. Symons founded the British Rainfall Organization to collect and publish rainfall data regularly. He also appreciated that for sensible studies of rainfall variation the gauges and methods of observation should be standardized and should not be unduly affected by local effects and procedures. He issued instructions on the correct siting of gauges, e.g. on level ground away from obstructions, and set a standard time of observation of daily rainfall accumulations, 0900 GMT.

The earliest volume of *British Rainfall* was for 1860 and contained data for 500 sites in the United Kingdom (including all Ireland). The rapid growth of the water distribution system during Victorian times was accompanied by a corresponding expansion in the number of rain-gauges so that in 1900 data for 3500 gauges were published. Of these by far the largest percentage, approximately 70%, were maintained by landowners and 'gentlemen', 9% by ladies and 8% by waterworks and local councils; a further 9% of gauges were maintained by parsons, presumably because the time of rainfall observations fitted in with their parochial duties. That total of 3500 gauges far exceeds the number of rain-gauges in many countries even today.

The British Rainfall Organization carried on until 1918, at which time nearly 5000 observers were active. It was now too large for a small semi-professional staff to manage. In that year the functions of the Organization were taken over by the Meteorological Office which continued to collect and to publish rainfall data under the *British Rainfall* title.

It is relevant to the theme of this article that the foreword to *British Rainfall* for 1919 contained the comment that '... due to the Great War the numbers of observers had declined because of disturbance to the routine of their lives but fortunately many of these were in districts where there was a surfeit anyway ...'. The writer goes on to speculate whether '... we are not in some cases actually overburdening ourselves with an unnecessary accumulation of data...'.

In spite of these words the number of gauges continued to increase, reaching about 6000 in the United Kingdom in 1980. Of the approximately 4000 gauges in England and Wales, 70% are now owned or maintained by the ten Regional Water Authorities who took them over from numerous River Boards and Water Companies in the reorganization of the water-supply industry of the early 1980s; the remaining 30% are owned by private observers, or are sited at the Meteorological Office's own stations or co-operating climatological stations.

3. Present-day processing of observations

The observations of daily rainfall made at these 4000 gauges are submitted to the Hydrometeorological Branch (Met O 8) of the Meteorological Office at Bracknell. They arrive at Bracknell on postcards, each of which carries a calendar month's observations. They come mainly via collecting centres for observations at Water Authority sites or directly from private and other observers. Observers in Scotland and Northern Ireland despatch their observations to the meteorological offices in Edinburgh and Belfast respectively.

Met O 8 is responsible for the checking, quality control and archiving of the rainfall observations made in England and Wales. These processes are today computer-controlled, this being the only practical way of handling the 4000 observations made each day (approximately 1.4 million per year). A central key to all of these processes is a comprehensive 'housekeeping' catalogue (called 'RAINMASTER') of the details of all known gauges past and present, totalling 15 000, which enables the organization of the work

to proceed. After an initial manual check on rainfall cards (legibility of writing, correct station number, etc.) they are submitted for entry into the computer for quality control. The success of the quality-control procedure depends on three factors: that on any day there is broad similarity in the rainfall measured by neighbouring gauges (on average these are about 6 km apart but in practice range from 1 km to over 30 km apart); that incorrect observations are the exception rather than the rule; and that a large proportion of the observations for any one time can be assembled quickly to allow the quality-control process to begin. Comparisons between measurements at adjacent gauges then reveal suspect observations and from a knowledge of the kinds of errors that are most commonly made, the computer program estimates a more likely value for the measurement which is thought to have been faulty. The most common errors are: completely missing observations, accumulations of rainfall on several successive days reported as one measurement, observations ascribed to the wrong date, and simple clerical and transcription errors. However, some obscure errors defeat the capability of the computer to suggest correction, and experienced staff then need to perform manual quality control; periods of snow or showers often result in this situation. In all cases staff have the final decision in accepting or rejecting computer-recommended amendments. When quality control has finished, the observations are archived in the computer and used to create monthly and annual rainfall totals which are published by the Meteorological Office annually under the title *Monthly and annual totals of rainfall for the United Kingdom* which replaced *British Rainfall* in 1969.

4. Who wants daily data anyway?

Daily rainfall observations are used in many ways, and requirements range from daily values on specific days at an individual station to complex statistical summaries of observations from many stations over many years. The Water Authorities and the Department of the Environment need to know of the characteristics of rainfall over Authority areas and the United Kingdom as a whole because water is an essential basic resource which is usually collected in one area where the rain falls and piped to another area where population and industry are concentrated. The collection and storage of water often involves the use of reservoirs and dams, so the statistics of the incidence of prolonged heavy rains are needed for safe engineering design and efficient operation, and for drainage and flood alleviation works generally. Rainfall often governs crop growth; too much rain requires efficient drainage, while too little rain requires extra irrigation. Thus the agricultural industry has an interest in a knowledge of likely rainfalls, both for long-term planning of capital projects and field-work, and for the cost–benefit assessment of investment. Architects and civil engineers require rainfall statistics so that adequate provision can be made for conducting rain-water away from buildings and built-up areas. The legal and insurance professions take an interest in observations of rainfall in connection with claims for damage or accidents or interruption of construction work caused by rain and flooding. Many institutions with diverse interests in weather-sensitive problems and in the environment require rainfall observations for study and research. In addition to the routine supply of data to the Water Industry and Government Departments, the Meteorological Office receives about 5000 non-routine enquiries for rainfall data each year. There is no indication that the demand for rainfall data will decrease in the next few years.

5. Requirement for reduction in numbers of gauges

Both the Meteorological Office and the Water Industry are under pressure to reduce the effort involved in the making, collection, checking and archiving of rainfall data. At the end of 1981 the National Water Council–Meteorological Office Joint Liaison Group set up a Working Group to make

recommendations on how these reductions could be brought about, while recognizing the continuing requirement for adequate or even improved rainfall data. The Working Group, which consisted of representatives of the Water Authorities, the Meteorological Office and other Government Departments, reported at the end of 1982. In summary its recommendations were:

(i) that the number of daily-read gauges in England and Wales whose data are to be stored in a central archive at Bracknell should be reduced from 4000 to about 2800 (this increases the average spacing between gauges from about 6.0 km to 7.2 km), i.e. a net reduction of about 30%;

(ii) that reductions should take place in those areas already well provided with gauges;

(iii) that in some areas which are now devoid of gauges efforts should be made to install gauges so that both generally and locally the recommended density of gauges is achieved;

(iv) that the gauges that are closed down should include a high proportion of those for which past experience indicates that there are difficulties in obtaining regular and reliable observations (for a variety of reasons);

(v) that gauges of particular interest should be retained (for instance those with a long record of observation are of significance to the Meteorological Office, Water Authorities and other institutions such as university research departments).

These recommendations have been accepted by the Joint Liaison Group and implementation has already started.

6. Practical aspects of reductions of the numbers of gauges

Much thought has gone into the implementation of these recommendations. It was known, for instance, that objective methods of 'rationalizing' rain-gauge networks would be very costly in terms of manpower and computer time. This conclusion was based on the experience from such a rationalization study which was carried out in 1978 for the Wessex Water Authority area jointly by the Institute of Hydrology, the Meteorological Office and the Authority. It involved a statement of the required accuracy of daily rainfall estimates following a review of user requirements and an elaborate procedure for estimation of rainfall at ungauged points based on historical rainfall statistics. The result was an indication of those areas where gauges could be removed, and also where a few new gauges were needed; the result was that the total number of gauges could be reduced by about 30%, while maintaining the required accuracy of observation. As a consequence of the effort involved in that exercise it was decided that the present country-wide reduction in gauges would need to use a simpler subjective method but based on the Wessex Water Authority area experience.

The practical procedures for choosing gauges to be retained in the reduced network consist of these steps:

(a) Mandatory gauges are specified by users (e.g. Water Authorities and the Institute of Hydrology for resource planning and flood control design; the Meteorological Office for country-wide rainfall and evaporation monitoring, meteorological studies, enquiries, catchment run-off studies, etc.).

(b) A matrix of grid squares of side x (where x is approximately 7 km) is specified.

(c) The relative importance of gauges is assessed using a scoring system which allots points for standard of exposure and equipment, regularity and quality of observation, length of record, altitude and remoteness of site and whether the site has other hydrometeorological instrumentation.

(d) For each square not containing a mandatory gauge the rain-gauge with the highest score is chosen.

(e) If a square contains gauges with an altitude range of greater than 50 m then two gauges at different heights are selected.

(f) Squares without gauges are noted for future 'gap-filling'.

The result of this procedure is a gauge network of generally no less than the required spacing but with a concentration of gauges in topographically complex areas. A computer program has been written by the Meteorological Office to carry out this design process automatically.

7. Progress in implementation of recommendation

The rain-gauge reductions are being carried out with each individual Water Authority independently. The Welsh Water Authority is the first being considered and this will establish the practicalities of the procedures. Fig. 1 shows the pre-reduction network of daily gauges in south and west Wales and, in comparison, Fig. 2 shows the post-reduction gauges. Note that the concentrations of gauges to the south of Plynlimon, on the Brecon Beacons and on the Black Mountains are considerably reduced. The gauges indicated by circles in Fig. 2 are new gauges in that though they existed previously they were not known to the Meteorological Office and no data were received from them; these gauges help to fill some gaps in the coverage. Inadequately gauged areas are also shown in Fig. 2, indicating where recruitment of rainfall observers should be pursued. The final net reduction in gauges in the Welsh Water Authority area will be about 30%.

Final agreement with the Severn-Trent Water Authority on reductions in their area is near and discussions with the remaining eight Authorities have commenced.

8. Conclusions

Although most of the gauges to be closed down are owned by Water Authorities with observations being made by their staff, inevitably some reports from gauges belonging to private observers will no longer be required, though these closures will be kept to a minimum. The efforts made by that peculiarly British institution — the enthusiastic, knowledgeable and dedicated 'amateur' — will not be discarded thoughtlessly and the nation's gratitude to the many amateur rainfall observers cannot be overstressed. Some individuals, over many decades, and indeed some families over several generations, have contributed to an archive of rainfall data which is a national asset that is the envy of many. Although some individual reports will no longer be included in the national archive, it is hoped that the observers will continue to make observations for their own satisfaction. It is only now, 65 years after the original suggestion, that the number of rain-gauges whose data are to be stored centrally is to be reduced so that the work load of maintaining the national archive can be handled with the available resources. Even after this reduction has been implemented the United Kingdom will still have one of the densest networks of rain-gauges of all countries.

The problems of rainfall assessment may have been largely solved but new crucial problems arise. Water quality, for example, and control of pollution are of concern to us all and new insights and procedures are required for the cost-effective design of safe water supplies and the safe discharge of excess rainfall and stream flow. Rainfall monitoring and data interpretation will have to continue into the foreseeable future and the rationalized reduced network of rain-gauges will be essential in providing the basic information from which progress in this work can be made.

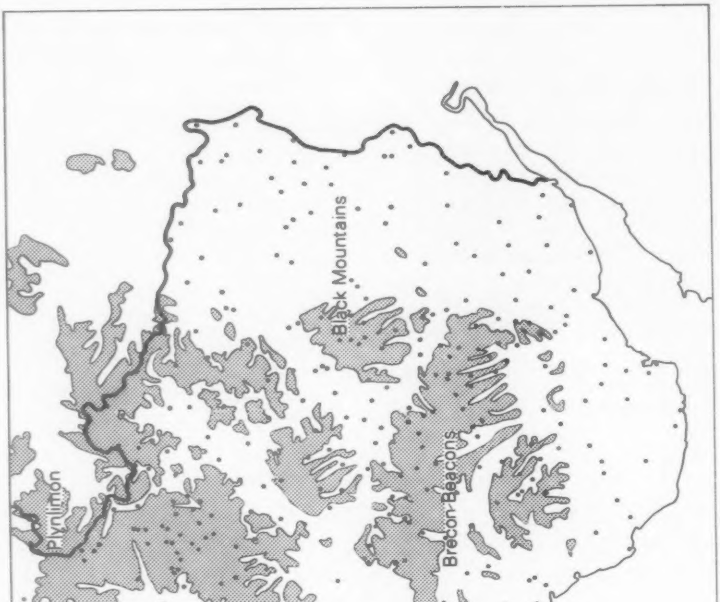

Figure 1. The pre-reduction network of daily rain-gauges in south and west Wales. Stations are denoted by dots.

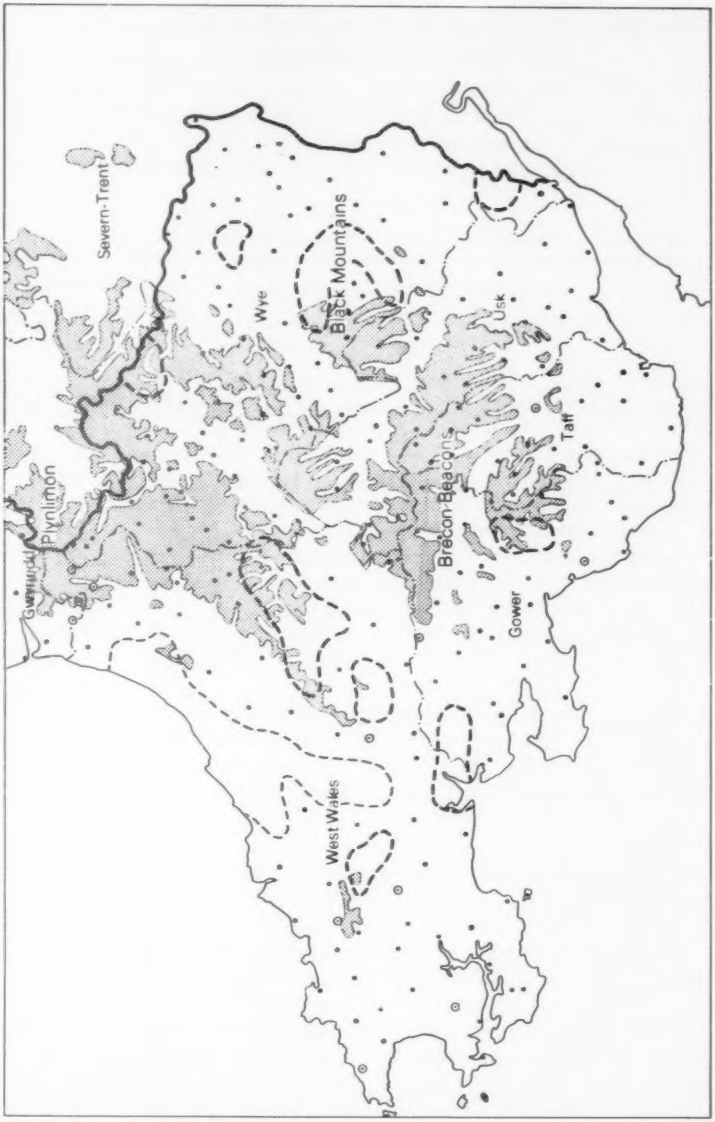

Figure 2. The proposed post-reduction network of daily rain-gauges in south and west Wales. Dots denote stations retained; circles show stations to be 'registered' with the Meteorological Office; and pecked lines enclose areas lacking in gauges. Dash–dot–dashed lines divide River Authority areas.

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Non-sinusoidal features of the seasonal variation of temperature in mid-latitudes

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Summary

Reasons for the non-sinusoidal nature of the seasonal variation of temperature in mid-latitudes are discussed. They are then used to explain the geographical and secular variations in the second harmonic of temperature previously found by Craddock and Smith.

1. Introduction

The seasonal variation of temperature in mid-latitudes is mainly, but not entirely, sinusoidal. Relatively well marked asymmetries in the march of monthly mean temperatures are illustrated in Fig. 1

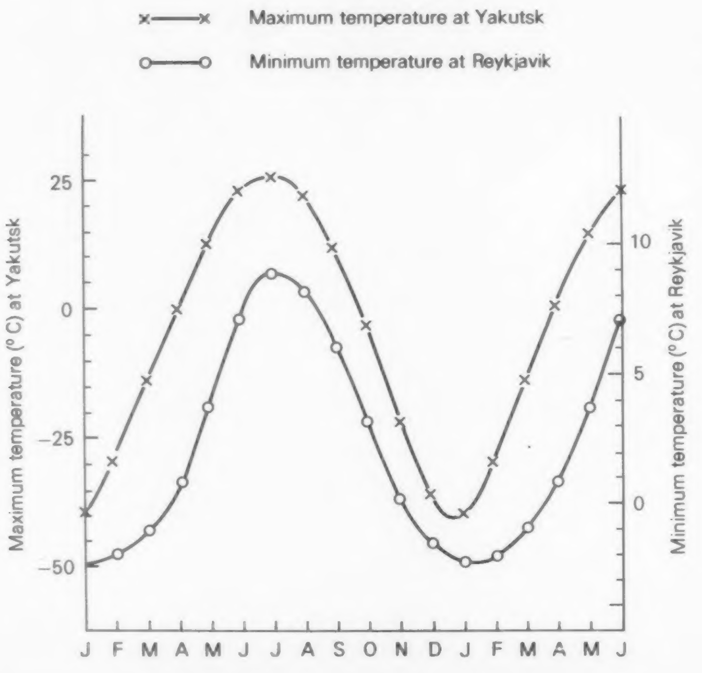

Figure 1. Seasonal variations of temperature at Yakutsk and Reykjavik.

for Yakutsk in Siberia and Reykjavik in Iceland. The departures from a purely sinusoidal annual cycle of temperature may be taken into account by using harmonic analysis and Craddock (1956a) has shown that two harmonics are sufficient to obtain an adequate representation of the seasonal variation of temperature. The non-sinusoidal component will then be represented by the second harmonic.

In a series of papers, Craddock (1955, 1956a, b) examined geographical variation in the first and second harmonics of mean temperature over the northern hemisphere, northern Europe, and the British Isles. Later, Smith (1984) examined temporal changes of these harmonics at Oxford and illustrated the difference between those for maximum and minimum temperature. The purpose of this note is to discuss the reasons for the non-sinusoidal variation of temperature, and to explain the findings of Craddock and Smith.

2. The non-sinusoidal nature of the seasonal variation of temperature

In mid-latitudes, departures from a purely sinusoidal seasonal variation of temperature may be expected for five reasons:

(a) *Solar elevation*

A change in the solar elevation has more effect on the radiation received at the surface when the sun is low in the sky than when it is high. At 50°N, for example, a rise in the solar elevation from 16° at the winter solstice to 21° 38 days later produces a greater change in radiation than the decrease from 63° to 58° as the summer solstice is passed. The changes in radiation received at the surface are therefore greater during the passage of winter months than summer months. The effect on the seasonal variation of temperature is to make the winter trough sharper than the summer peak.

The dates at which mean temperatures reach their highest and lowest values are also affected. The increase in radiation as the sun's elevation increases through January is greater than the corresponding decrease during July. Hence the date of the seasonal extreme of mean temperature lies nearer to the solstice in winter than in summer. A corollary is that the fall of temperature in autumn is more rapid than the rise in spring.

(b) *Lapse rates*

Mean lapse rates of temperature in the atmosphere vary seasonally, especially over the land, where they are greater in summer than in winter. The more stable the atmosphere is, the less the depth of the atmosphere that has to be heated or cooled. Over the continents, this factor contributes towards more rapid changes of temperature in winter than in summer, and hence a winter trough that is sharper than a summer peak.

(c) *Sea temperature*

In winter, the surface layers of the oceans are well mixed and the vertical structure of sea temperature is approximately isothermal. In summer, however, the surface layers are warmer than those below and the depth of ocean which is being heated or cooled is much less than in winter (see, for example, Wells (1982)). It follows that sea temperatures change more readily in summer than in winter, and their seasonal variation is characterized by a summer peak that is much sharper than a winter trough.

(d) *Seasonal changes in the relative importance of radiation and advection*

Compare two locations with different climates, the first calm and sunny, the second windy and overcast. One would clearly expect the first location to have the greater seasonal variation of temperature, with the dates of the maximum and minimum closer to the solstices than those at the second location. Consider next a single location where the summers are calm and sunny and the winters windy and cloudy. The effect on the seasonal variation of temperature is to make the summer peak sharper than the winter trough.

(e) *Seasonal changes in the frequency of northerly and southerly winds*

In the northern hemisphere, a predominance of northerly winds in winter and summer and southerly winds in spring and autumn will make the winter trough sharper than the summer peak. A greater frequency of northerly winds in the first halves of winter and summer compared to the second halves of those seasons may advance the winter trough and delay the summer peak. Although changes in the frequencies of cold and warm winds do occur, they generally have a periodicity of 12 rather than 6 months, and therefore affect the first, rather than the second, harmonic.

3. Interpretation of the harmonics

The combined effects of the first and second harmonics are described by Craddock (1956b), but are repeated here for convenience. Fig. 2 demonstrates the addition of a first harmonic, with trough and peak in January and July respectively, to a second harmonic, whose amplitude is 20% of the first. Figs 2(a) and 2(b) show that when the peak of the second harmonic is in phase with that of the first, the summer peak is sharpened. Figs 2(c) and 2(d) show that when the peak of the second harmonic is delayed by 46 days, the date of the winter trough is advanced while that of the summer peak is delayed. If the second harmonic peaks 92 days after the first, it is the winter trough which is sharpened. Thus if the peak of the second harmonic lags behind the first by up to 46 days, the effect is that of a sharp summer peak combined with an asymmetric rise and fall of spring and autumn temperatures. If the lag of the second harmonic is between 46 and 92 days, the asymmetric rise and fall of temperature is combined with a sharp winter trough.

The second harmonic does not express explicitly the two main features of the non-sinusoidal behaviour of temperature. The amplitude does not distinguish between sharp summer peaks or winter troughs, while the phase compounds this information with the asymmetry in the spring rise and autumn fall of temperature. A description of the non-sinusoidal variations in temperature would therefore be made clearer by the use of two 'second harmonics' with phases fixed at 0 and 46 days with respect to that of the first harmonic. The first of these second harmonics would then measure the relative sharpness of the summer peak to the winter trough, while the second would contrast the rate of spring rise in temperature to the autumn fall.

4. Geographical variations in the harmonics of mean temperature

Craddock (1955) has calculated the first and second harmonics of mean temperature for 305 stations in the northern hemisphere using monthly mean temperatures for 1921–40. The first harmonic simply reflects the increased amplitude and advanced phase of temperature variations over the continents with respect to those over the oceans. The main findings concerning the second harmonic are reproduced in Figs 3 and 4.

Fig. 3 displays the difference in phase between the first and second harmonics of mean temperature. This is shown to lie between 0 and 45 days over the oceans and Arctic, and between 45 and 90 days over the continents. An autumn fall faster than a spring rise of temperature is therefore indicated, combined with a sharp summer peak over the oceans and a sharp winter trough over the continents. These features are in accord with the relative importance of radiation and sea temperatures in determining the seasonal variation of air temperatures. In the Arctic, the long winter night also contributes towards the establishment of a flat winter minimum. Over the oceans and northern continents, the relative importance of radiation to advection in the climate is greater in summer than in winter. This enhances the well-defined summer peak over the ocean, where there is a feedback on sea temperatures, and sharpens the flat summer peak over the continents. Over the more southerly continental areas, the

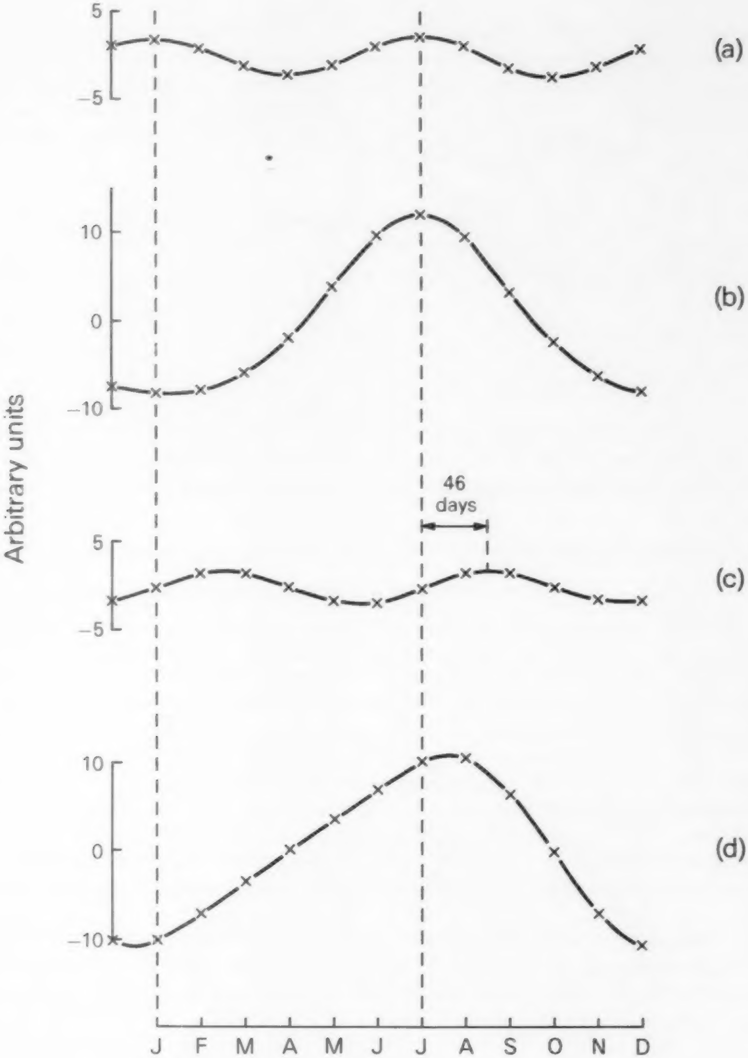

Figure 2. Combinations of first and second harmonics: (a) isolated second harmonic with peak in phase with peak of first harmonic; (b) addition of first harmonic to second harmonic (a) (sharp summer peak); (c) peak of second harmonic 46 days after peak of first harmonic; and (d) addition of first harmonic to second harmonic (c) (slow spring rise and rapid autumn fall). Dashed lines represent trough and peak of first harmonic.

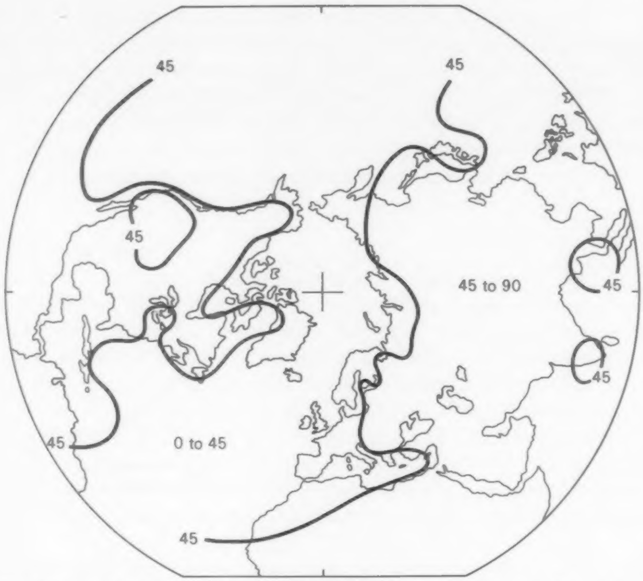

Figure 3. The difference in phase (days) between the first and second harmonics of mean temperature.

Figure 4. The ratio of amplitude of the second to the first harmonic of mean temperature, expressed as a percentage

monsoonal climate causes the relative importance of radiation to be greater in winter than in summer and this enhances the sharp winter trough in those regions.

Fig. 4 displays the ratio of the amplitude of the second harmonic to that of the first, and shows that the second harmonic is more important over the oceans and towards the tropics than over the temperate continents. The sea temperature is seen to introduce a larger non-sinusoidal component over the ocean than radiation does over the continents. In the tropics, of course, the second harmonic assumes greater importance because of the occurrence twice in a year of the overhead sun.

5. Differences in the harmonics of maximum and minimum temperature

Maximum temperatures respond to solar radiation more rapidly than minima which are more dependent on dew-point and therefore on sea temperatures. These differences can be seen in the findings of Smith (1984) who reports that, at Oxford, for example:

(i) The phase of the first harmonic of maximum temperatures is 8 days ahead of that for minima.

(ii) The phase difference between the first and second harmonics is 30 days for maxima, but only 5 days for minima. This shows that the asymmetry in the seasonal rise and fall of temperature is pronounced for maxima, but almost absent for minima.

(iii) The ratio of the amplitudes of the second to the first harmonic is 13% for minima but only 7% for maxima. This shows that for the maritime climate of the United Kingdom, as exemplified by the records for Oxford, the relative sharpness of the summer peak to the winter trough is greater for minima than for maxima.

6. Secular variations in the harmonics of temperature

Using data from 1861 to 1980, Smith (1984) showed that the amplitude and phase of the second harmonic of temperature at Oxford have undergone considerable changes with time. It will now be shown that these variations are an expression of changes in the continentality of climate at Oxford.

Increasing continentality is associated with changes in the relative sharpness of the winter trough to the summer peak. For minima, in which the asymmetry in the seasonal rise and fall of temperature is small, this will be associated with a decline of a second harmonic which is in phase with the first, followed by the growth of a second harmonic which lags behind the first by around 92 days. For maxima, the asymmetric rise and fall of temperature prevents the amplitude of the second harmonic from falling to zero. Increasing continentality is, therefore, associated with an increase in lag of the second harmonic with respect to the first. As discussed in section 3, a phase lag of up to 46 days combines an asymmetric rise and fall with a sharp summer peak, while a lag of between 46 and 92 days combines the asymmetry with a sharp winter trough.

Smith's results are summarized in Fig. 5. It can be seen that an increase in phase difference between the first two harmonics of maximum temperature is highly correlated with a decrease in the amplitude of the second harmonic of minimum temperature (note the inverted scale), and with the amplitude of the first harmonic of minimum temperature. The last named may be regarded as a direct measure of the continentality of climate.

7. Conclusions

Departures from a purely sinusoidal annual cycle of temperature are due to the effects of solar elevation, sea temperatures, and the relative importance of radiation and advection at a particular

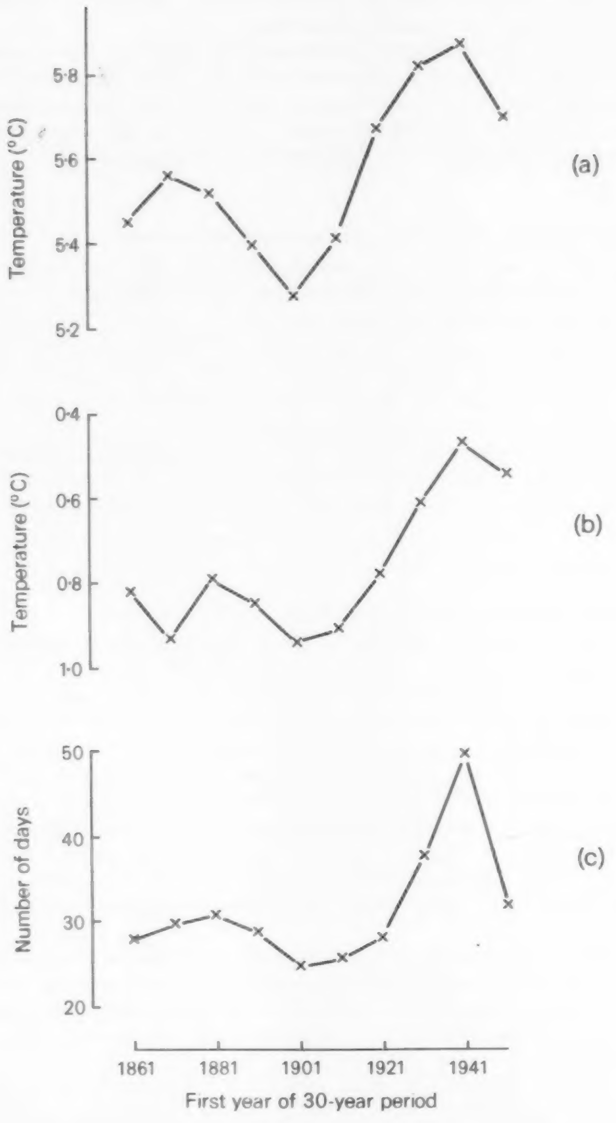

Figure 5. Secular variations of harmonics of temperature at Oxford: (a) amplitude of first harmonic of minimum temperature; (b) amplitude of second harmonic of minimum temperature; and (c) phase difference between peaks of first and second harmonics of maximum temperature.

location. The non-sinusoidal behaviour is characterized by two main features, namely a difference in the sharpness of the summer peak compared to the winter trough, and an asymmetry in the spring rise and autumn fall of temperature. These features are best represented by two 'second harmonics' with phases fixed at 0 and 46 days with respect to that of the first harmonic. These characteristics can, however, also be related to the phase and amplitude of the conventional second harmonic, and used to explain the geographical and secular variations in these parameters found by Craddock and Smith.

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Awards

L. G. Groves Memorial Prizes and Awards

The award of prizes, the first under the new arrangements forecast in the account of last year's prize giving, took place on Tuesday 8 November 1983 at the Main Building, Ministry of Defence, Whitehall. The Vice-Chief of the Air Staff, Air Marshal Sir Peter Harding, KCB, presided.

Under the will of the late Mrs Dorothy Groves, who died in June 1980, a further large sum of money was added to the previous endowment of the L. G. Groves Memorial Prizes and Awards. Over the following two years discussions were held involving the Trustees, the Royal Air Force, the Meteorological Office, M.o.D. Headquarters, and the Charity Commissioners in order to reorganize the terms of the Awards, and new rules were finally agreed and promulgated early in 1983. The main change from the previous arrangements was that teams, as well as individuals, became eligible for awards, and each member of the team would receive an individual prize.

Air Marshal Sir Peter Harding opened the proceedings and expressed the thanks to Mr Nicholas Abbott of all those concerned with the arrangements for his services in presenting the awards since the death of Major Groves. He announced that Mr Abbott was now standing down in favour of his cousin, Mr Robin Wight. He gave a resumé of the new regulations, explaining that the monetary value of the annual prizes was now substantially increased, and congratulated the winners. Mr Abbott acknowledged the remarks of Sir Peter Harding and, after referring to his late great-uncle, Major Groves, introduced Mr Wight. Mr Wight, who is a director of a private commercial firm, said that he had been reading through the citations for the various awards since they were introduced, and had been much impressed by the detail they went into and the evidence they gave of the great importance to aircraft safety of the work for which the awards had been given. Air Commodore T. H. Stonor (Inspector of Flight Safety, RAF) then read the citations for the prize-winners, and Mr Wight presented them with their prizes and certificates, adding his own personal congratulations.

The 1982 Aircraft Safety Prize was awarded to Senior Aircraftman E. B. Govan of RAF Chivenor in recognition of his inventiveness and initiative in designing and producing a modification to the Personal Survival Pack Line Assembly of the Hawk Parachute Harness. This facilitates easy release especially in water. This modification may have a wider application to other aircraft equipped with a similar ejection seat. It is very simple in concept and is comparatively inexpensive.

The 1982 Meteorology Prize was awarded jointly to Dr P. W. White, Dr T. Davies, Dr A. Dickinson and Dr W. H. Lyne, of the Meteorological Office with the following citation:

> 'Dr White was the Project Officer for the development of a new numerical weather prediction system to provide improved forecast guidance for the Meteorological Office. Within the project team, the groups dealing with the forecast model were led by Drs Davies and Dickinson, and that with analysis by Dr Lyne.
>
> The operational numerical analysis and weather prediction system is the heart of the Meteorological Office's forecasting activities. It incorporates much of our understanding about the behaviour of the atmosphere, as well as extensive knowledge about observations and observing systems. To replace the previous highly developed system with an improved version was a major undertaking calling for outstanding scientific expertise and technical and managerial skills of a high order.
>
> The new system differs from the old in providing higher resolution over the whole globe. Consequently numerous scientific and technical problems were experienced, which had not previously been encountered. A basic feature of the new design is that the analysis scheme assimilates observations by modifying the forecast model's atmospheric variables as the model is integrated

L. G. Groves Memorial Prize and Award Winners standing (left to right: Mr B. Greener, Sergeant R. Clay, Dr W. H. Lyne, Dr T. Davies, Dr A. Dickinson, Dr P. W. White, SAC E. B. Govan and Sqn/Ldr M. K. Allport) with, seated left to right, Mr Robin Wight, Mr Nicholas Abbott, Air Marshal Sir Peter Harding, KCB, and Air Commodore T. H. Stonor.

Dr P. W. White, Project Officer for the team which won the Meteorology Prize, receives his prize from Mr Robin Wight.

forward in time. The method is inherently extremely flexible, able to deal with a wide variety of types of observation, such as those from satellites and commercial aircraft with reporting and error characteristics quite unlike those of the conventional synoptic network. Work on the model and analysis techniques had therefore to be carefully co-ordinated, particularly to ensure that the whole system maintained dynamical consistency as the effects of new observations were incorporated.

The results from the new system have been notably successful. Although new and untried features were involved, a clear superiority over the old system was soon established. It was particularly fortunate that the development proceeded quickly enough for a version of the system, albeit not fully tested and evaluated, to be used as a basis for forecasts in support of the Task Force during the Falklands Campaign. The usefulness of the predictions at that time vindicated the basic design. Subsequently real-time testing led to further improvements in various aspects, including the analysis and prediction of jetstreams which are crucial for aircraft operations.'

The Meteorological Observer's Award for 1982 was awarded jointly to Squadron Leader M. K. Allport, HQ, RAF Support Command and Mr B. Greener of the Meteorological Research Flight, Royal Aircraft Establishment, Farnborough, with the following citations:

'Sqn/Ldr Allport completed a three-year tour as officer commanding the RAF unit of the Meteorological Research Flight (MRF) in September 1983. He very quickly demonstrated his interest in, and appreciation of, the meteorological objectives of MRF, and has played a very active and enthusiastic role with research scientists in the planning and execution of their experiments. Particularly notable was his contribution to an international meteorological research project (KONTUR) carried out over the German Bight in autumn 1981. Sqn/Ldr Allport's leadership and dedication have been major factors in the accomplishment of meteorological research objectives, often involving demanding flying requirements.'

'Mr B. Greener joined MRF in 1971. He has worked on electronic aspects of experimental instruments of specialized navigational equipment and, most recently, as head of the electronics section, on the new data recording system for the Hercules. In addition to these technical tasks, he took a very active role in the flying program, and became one of the most experienced observers on the Canberra aircraft. Through his outstanding technical ability and skill as a meteorological observer in the air, Mr Greener has made a remarkable and wide-ranging contribution to the success of many MRF projects'.

The 1982 Second Memorial Award was made to Sergeant R. Clay of RAF Chivenor (late of the Institute of Aviation Medicine, Farnborough) in recognition of his achievement in developing an aeromedical stretcher harness which has been tried and tested successfully, particularly in recent operations, and has now been introduced into service.

Notes and news

Retirement of Mr P. Graystone

Mr P. Graystone, Assistant Director, Data Processing, retired from the Meteorological Office on 25 January 1984 after a career lasting nearly 43 years. After initial training in 1941, he held a commission in the RAFVR from November 1942 to May 1947, a period which included three years' service in India and the Middle East.

He returned as an Assistant Experimental Officer to aviation forecasting at Hendon and Northolt and, after promotion to Experimental Officer in 1950, moved to Cranwell. He gained an external Honours Degree in Mathematics from London University in 1951 and became a Scientific Officer the following year.

Paul Graystone's first spell of research began with a move to Victory House in 1953, to work on equivalent head winds, and he was promoted to Senior Scientific Officer a year later. Between 1956 and 1958, he was associated with the planning and organization of the Christmas Island experiments, and produced an early analysis of upper winds near the equator.

The year 1959 saw his introduction to research on numerical weather prediction at Dunstable and with it his first taste of computing. He was promoted to Principal Scientific Officer in 1960. By 1963, now at Bracknell, he was developing the procedures for introducing operational forecasting on the KDF-9, and a couple of years later moved to the Forecasting Techniques Branch (Met O 8a) to work on the operational aspects of automatic data assimilation, analysis and output.

A second interlude of overseas service, as Chief Meteorological Officer Bahrain, lasted from 1967 to 1969. Back at Bracknell, Paul was immediately involved with the introduction of the 10-level model on the IBM 360/195. In 1972 he joined the Committee on the Meteorological Effects on Stratospheric Aircraft group in the Dynamical Climatology Branch (Met O 20), and played an active part in modelling the stratospheric phenomena of relevance to supersonic transport operations, as well as in the many organizational aspects.

In 1974 he was promoted to Senior Principal Scientific Officer and spent three years as Assistant Director, Forecasting Research, and a further three years as Assistant Director, Dynamical Climatology, where his ability to handle the organizational aspects of complex scientific programs was well demonstrated. Paul's last assignment, in 1979, as Assistant Director, Data Processing, has made good use of his computing experience and unobtrusive management skills, and has seen the successful introduction of the Cyber 205 and IBM 3081.

In recent years, Paul Graystone has not always been in the best of health, but we hope that this will neither inhibit his golfing pursuits nor distract from the individual style of competitive bridge which he has pioneered. We wish him and Mrs Graystone a long and happy retirement.

M. J. Blackwell

50 years ago

The following extract was published in the *Meteorological Magazine*, March 1934, **69**, 38–39.

In Lighter Vein

Many inquiries have been made as to the cause of the abnormal drought: and various tentative suggestions have been put forward to explain it. One school attributes it to a change in the volume of the Gulf Stream drift: another suggests that radio-broadcasting has used up most of the ions previously available as nuclei of condensation.

A more plausible reason has recently come to my notice. It is well known that rain in England is mainly derived from evaporation from the Atlantic Ocean; and further that evaporation from spray is much more effective than evaporation from a water surface. A most effective producer of spray is a spouting whale: but there has been so great a reduction in the number of whales in the North Atlantic that this source of rainfall has been nearly cut off — hence the drought.

E. Gold

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NOTICES

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